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TRACKING VARIATIONS IN COCAINE DEATHS ACROSS U.S. CITIES

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Both the Drug Abuse Warning Network (DAWN) data and the National Center for Health Statistics (NCHS) vital statistics datasets have been criticized for inaccurate recording of cocaine deaths. This study compares the number of cocaine deaths per capita reported in these two datasets for the years 1981 through 1998 and for 24 U.S. cities. Both datasets identify significant differences in trends in cocaine deaths across U.S. cities. The DAWN dataset is limited to a select number of metropolitan areas, but appears to provide a more comprehensive count of cocaine deaths in those cities. Although the NCHS vital statistics undercount cocaine deaths in many cities, changes over time are well correlated with DAWN data. Therefore, NCHS vital statistics can be used to track variations in cocaine use overtime in regions not surveyed by DAWN.

Keywords: Cocaine; Substance abuse; Mortality trends

INTRODUCTION

Regional differences in drug abuse can be used to identify the sociodemographic factors, policies, and public health interventions which are associated with drug use. Several studies have also made use of region-level data to examine the relationship between drug abuse and crimes such as robbery, illegal gun possession, and homicides (Baumer *et al*., 1998; Cork, 1999; Grogger and Willis, 2000). Further, regional data can be used by local policy makers to track drug abuse trends in their specific location (Caulkins *et al*., 1995).

One indicator of drug use in the literature is the number of drug deaths per capita (Rosenfeld and Decker, 1999; Garfield and Drucker, 2001). This study examines regional variations in cocaine deaths per capita as reported from two different sources.

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The Center for Disease Control's (CDC) National Center for Health Statistics (NCHS) compiles vital statistics based on cause-of-death statements reported in death certificates. Cocaine deaths at the county level can be identified using the NCHS data files, which code multiple causes of death using International Classification of Disease (ICD-9) codes for conditions reported on death certificates.

Another source of information on cocaine deaths is the Drug Abuse Warning Network's (DAWN) Medical Examiner (ME) database, maintained by the Substance Abuse and Mental Health Services Administration (SAMHSA). In 2001, The DAWN-ME database collected information on drug abuse mortality from 128 medical examiners' or coroners' offices in 42 metropolitan areas.

Past researchers have noted advantages and disadvantages of using either the vital statistics or the DAWN-ME data to measure regional differences in cocaine deaths. A comparison of DAWN-ME and NCHS data from the 1980s suggests that NCHS vital statistics under-reports cocaine deaths relative to DAWN-ME (Pollock *et al.*, 1991). However, the DAWN-ME data is only available for select metropolitan areas. Even in these areas, not all medical examiners or coroners report drug deaths for inclusion in DAWN-ME (Wysowski *et al.*, 1993; Caulkins *et al.*, 1995; Rosenfeld and Decker, 1999). We draw data from both the 1980s and 1990s from the DAWN-ME and NCHS vital statistics databases to calculate the number of cocaine deaths per capita for cities represented in both databases. We then compare these two measures to determine their consistency over time within cities. Further, we examine changes over time in drug deaths across cities. Finally, we discuss the implications of our findings for future regional studies of cocaine use.

Some past studies have used law enforcement indicators, such as urine tests indicating drug use among arrestees to proxy for differences in drug use across different cities. However, the prevalence of drug use among criminal arrestees provides a biased measure of illicit drug use in a city's overall population. Drug enforcement policy and resulting arrest rates can vary across cities due to a range of social and political factors, which are not necessarily associated with variation in drug use (Currie, 1993).

Relying on drug deaths as a measure of drug use also has limitations. For instance, one captures only the most serious cases of illicit drug use, and these deaths may also depend on differences in health care systems across cities. Cities may vary in terms of the time required for 911 to transport a drug overdose patient to the hospital, the availability of emergency rooms or waiting time in an emergency room, or the quality of health care professionals treating drug abusers. However, cocaine death is certainly an important adverse consequence of drug use that public health workers seek to reduce. Determining whether drug deaths vary by city due to local differences in the quality of the health care system is an important question which is beyond the scope of this article.

We focus our analysis on cocaine deaths, because a number of studies have shown the relation between the consumption of cocaine and a variety of social and health problems (Levine *et al.*, 1990; Marzuk *et al.*, 1995; Baumer *et al.*, 1998; Cork, 1999; Grogger and Willis, 2000; Crandall *et al.*, 2002; Jeynes, 2002). However, concern has increased over heroin use in the last decade (Anonymous, 2001; Sporer and Dorn, 2001). Therefore, we also present some aggregate data which suggests how our results would differ if we compared heroin deaths and overall drug deaths in the DAWN-ME dataset with the NCHS dataset.

METHODS

The DAWN-ME is managed by Westat on behalf of SAMHSA. The DAWN-ME collects data on cocaine-related deaths from medical examiner and coroner jurisdictions in select metropolitan areas. In each participating facility, a staff member or trained recorder provided by Westat is the designated "DAWN Reporter" who reviews all available patient/decedent records to determine whether each death was drug-related (Drug Abuse Warning Network, 2003a). Deaths tabulated in the DAWN-ME annual reports are those in which drug abuse either caused or contributed to death. Drug abuse is defined by DAWN as the nonmedical use of a legal drug or any use of an illegal drug for psychic effect, dependence, or suicide (Substance Abuse and Mental Health Services Administration, 2002). Drug abuse is further divided into drug types, including cocaine (including crack), heroin, marijuana, and amphetamines.

Prior to 1994, the DAWN data was not adjusted for differences in the number of facilities which chose to participate in the survey from year to year. However, in 1991 and 1994 DAWN also reported the number of cocaine deaths for each of the three preceding years for the same facilities reporting in the current year. For example, one might find a higher number of cocaine deaths reported in a city for 1991 in the 1994 report, than in the 1991 report. By working backwards from 1994 to 1981, we adjusted the reported number of cocaine deaths in each year using the proportional difference in deaths between any two annual reports indicating different numbers for the same year and city. The years in which two counts of cocaine deaths for the same city existed in overlapping time series were 1988, 1991, and 1994.

The second measure of drug deaths is based on mortality associated with drug abuse as reported in the vital statistics system, which is maintained by NCHS. The NCHS compiles annual multiple-cause-of-death data sets using International Classification of Diseases (ICD-9) codes for conditions reported on death certificates (National Center for Health Statistics, 2003a). The multiple-cause-of-death data provide codes for up to 20 conditions per death, including the single underlying cause of death, the immediate cause of death, causes that intervene between the underlying and immediate causes of death, and any contributory causes (Pollack *et al.*, 1991; National Center for Health Statistics, 2003b).

Following past research, cocaine deaths in the NCHS vital statistics were first identified using the following ICD-9 codes: 304.2 (cocaine dependence), 305.6 (abuse, cocaine; nondependent), E855.2 (local anesthetics including cocaine) 938.5 (surface and infiltration anesthetics – cocaine, procaine, lidocaine, and tetracaine), 968.5 (surface and infiltration anesthetics including cocaine). We then excluded from this search any deaths in which the underlying causes were medical misadventures (ICD-9 E870–E876), abnormal reactions to medical procedures (ICD-9 E878–E879), or adverse effects of drugs in therapeutic use (ICD-9 E930–E949), see Pollack *et al.* (1991).

NCHS data was aggregated to metropolitan areas to enable comparison with DAWN-ME. In 2001, the DAWN-ME data reported information on drugs deaths in 42 metropolitan areas. These metropolitan areas are generally larger than individual cities and include the major city and its surrounding counties (Drug Abuse Warning Network, 2003b). The definition of each metropolitan area is provided in DAWN-ME publications (Substance Abuse and Mental Health Administration, 2002). Each individual death record in the NCHS vital statistics contains a county identifier. Therefore, county-level cocaine deaths in the NCHS vital statistics can be aggregated into metropolitan areas based on DAWN-ME geographic definitions in order to obtain comparable geographic areas across the two datasets. Information on cocaine deaths from 24 metropolitan areas was available from both DAWN-ME and the NCHS vital statistics for all years from 1981 to 1998. We use the terms ''metropolitan area'' and ''city'' interchangeably throughout this article.

To compare the prevalence of drug deaths across cities, the number of drug deaths for each year and city were divided by the total population in each metropolitan area. The population for each metropolitan area and year was determined by summing annual population counts for each relevant county, which are available in the Area Resource File (Bureau of Health Professions, 2002). We computed the average annual cocaine deaths per capita by city in both the DAWN-ME and NCHS datasets. We then computed the correlation across the two datasets for the annual number of cocaine deaths per capita for all 24 cities combined, as well as for each individual metropolitan area. We also constructed graphs to compare trends in per capita cocaine deaths over time for all cities combined and for select cities.

RESULTS

Figures on the number of cocaine deaths, cocaine deaths per capita, and the correlation in deaths per capita for each city in the DAWN-ME and NCHS vital statistics are reported in Table I. Over the period 1981 to 1998, the DAWN-ME reports more cocaine deaths per capita than the NCHS vital statistics (0.29 *versus* 0.16).

TABLE I Cocaine deaths by metropolitan area, 1981–1998

	Total number of deaths		*Average annual deaths per 10,000 individuals*		
	DAWN	*Vital statistics*	*DAWN*	*Vital statistics*	*Correlation*
Atlanta	1094	992	0.27	0.24	0.90
Baltimore	2197	937	0.50	0.21	0.96
Buffalo	204	100	0.10	0.05	0.31
Chicago	3311	2940	0.26	0.23	0.95
Cleveland	354	348	0.14	0.14	0.96
Dallas	1157	539	0.23	0.11	0.94
Denver	413	610	0.11	0.17	0.91
Detroit	2152	775	0.28	0.10	0.71
Indianapolis	62	133	0.04	0.08	0.53
Kansas City	264	175	0.18	0.12	0.96
Los Angeles	6668	4094	0.42	0.26	0.90
Miami	1726	903	0.50	0.26	0.66
Minneapolis	192	296	0.04	0.06	0.64
New Orleans	623	345	0.28	0.16	0.94
Norfolk	195	158	0.14	0.12	0.87
Oklahoma City	327	86	0.29	0.08	0.86
Philadelphia	4208	1013	0.48	0.12	0.97
Phoenix	756	471	0.18	0.11	0.93
San Antonio	473	248	0.21	0.11	0.92
San Diego	1126	713	0.25	0.16	0.95
San Francisco	1804	871	0.62	0.30	0.83
Seattle	701	698	0.19	0.19	0.99
St. Louis	846	496	0.19	0.11	0.95
Washington	1732	446	0.25	0.06	0.60
TOTAL	32,585	18,387	0.29	0.16	0.78

Yet the overall correlation for the annual number of cocaine deaths per capita between the two datasets was 0.78. In general, the estimates of the annual number of cocaine deaths per capita for individual metropolitan areas were well correlated over time. The average correlation between the two datasets at the metropolitan area level was 0.84. The lowest correlation between the two datasets was 0.31 in Buffalo, and the highest correlation was 0.99 in Seattle.

The correlation between the two datasets was greater than 0.80 for 75%, or 18, of the 24 cities. In addition, 63%, or 15, of the cities had a correlation between the vital statistics and DAWN-ME data that was greater than or equal to 0.90. Of the five cities with the lowest correlations, three were cities with low populations that reported relatively low cocaine deaths per capita (Buffalo, Indianapolis, and Minneapolis). The small sample size in these cases suggests that correlations across the two datasets for these three cities can easily be influenced by small amounts of measurement error in the number of cocaine deaths. However, when one aggregates the number of cocaine deaths per capita for Buffalo, Indianapolis, and Minnesota, the correlation between the DAWN and vital statistics improves dramatically to 0.85.

Figure 1 graphs the number of cocaine deaths per capita for the DAWN and vital statistics for all the 24 metropolitan areas combined and for 5 individual cities. For all areas combined, the DAWN reports more deaths per capita than the vital statistics in each sample year. The differential between the two datasets appears to have increased as the number of drug deaths has risen. The five cities in Fig. 1 were chosen for their locations across different parts of the country, their different patterns of cocaine deaths over time, and their range of correlation between the two datasets. Both Atlanta and Seattle display a steady increase in cocaine deaths per capita over time. In contrast, Baltimore experienced a sharp increase in cocaine deaths in the

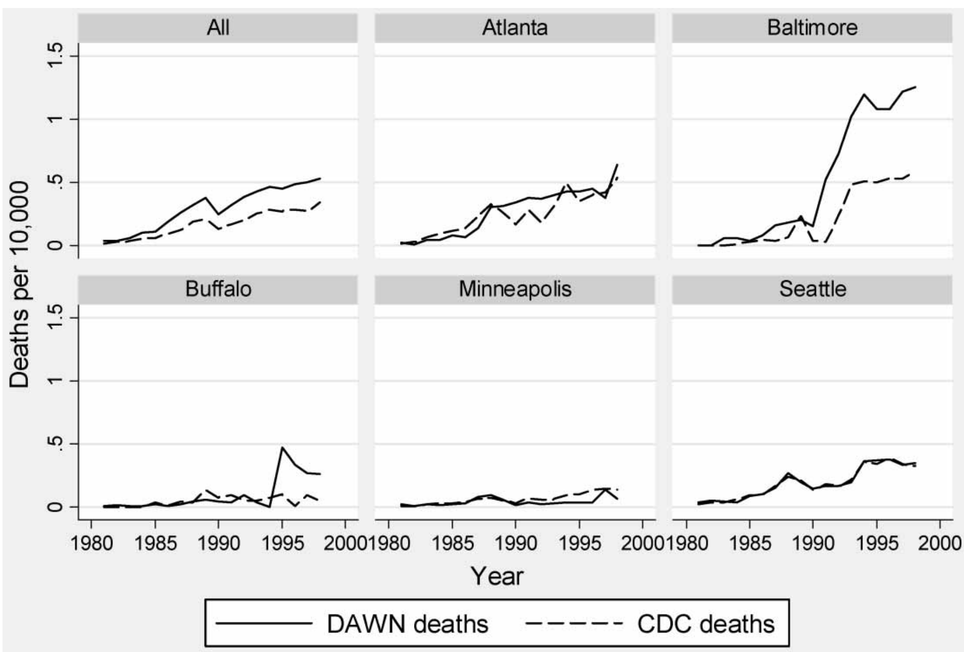

FIGURE 1 Number of cocaine deaths per 10,000 individuals by metropolitan area, 1981–1998.

early 1990s. Minneapolis and Buffalo appear to have experienced very little growth in cocaine deaths per capita over the past two decades, although the DAWN-ME suggests a slight increase in cocaine deaths in the last three years of the sample period for Buffalo. The relatively low correlation between the DAWN-ME and NCHS vital statistics for Buffalo and Minneapolis is masked by the identical scaling of deaths per capita across cities in Fig. 1. Therefore, although year-to-year changes in cocaine deaths were not highly correlated for these cities, both datasets indicated that these cities reported relatively few cocaine deaths per capita.

DISCUSSION

The results in this study indicate that the DAWN-ME and NCHS vital statistics datasets provide different but valuable information that can be applied to the task of drug surveillance. A study conducted by Pollock *et al.* (1991) compared cocaine deaths reported in the DAWN and vital statistics from 1983 to 1988 and found trends in the two datasets to be comparable. Similarly, Garfield and Drucker (2001) compared the total number of drug-induced deaths reported in the NCHS vital statistics, DAWN-ME overdose deaths, and DAWN drug related deaths for the year 1990 to 1997. Garfield and Drucker found that despite differences in definitions and methods, the three measures yield comparable estimates of yearly drug deaths for 27 cities combined. However, Garfield and Drucker did not examine whether these datasets give consistent estimates for individual cities. Pollock *et al.* compared drug deaths by city. However, they compared the DAWN-ME and NCHS vital statistics using the total number of drug deaths by city, rather than examining drug use per capita. The authors' analysis is potentially misleading, because both datasets are more likely to identify more deaths in larger cities, which can lead to unduly favorable correlations. We revisit this comparison using cocaine deaths per capita as our unit of measure and find that comparability between the DAWN-ME and NCHS vital statistics is still very good. The correlation in annual deaths per capita between the two datasets was greater than 0.80 for 75%, or 18, of the 24 cities. In addition, 63%, or 15, of the cities had a correlation between the vital statistics and DAWN-ME data that was greater than or equal to 0.90. Also, graphs of cocaine deaths in individual cities show that the large upswing in cocaine deaths identified by Pollock in 1986–88 has continued for many, but not all U.S. cities.

Similar to the Pollock *et al.* study, we find that the DAWN-ME data almost always report a higher number of cocaine deaths in each metropolitan area relative to NCHS vital statistics. Past literature suggests that the NCHS data under-reports cocaine deaths, because medical examiners can fail to record relevant data on the death certificates in a manner which leads to an assignment of a cocaine-related ICD-9 code (Young and Pollock, 1993). For example, in a sample of 446 deaths in which all relevant medical and legal documents were examined by a panel of physicians, the ICD-9 codes on the death certificates showed a sensitivity equal to only 50% for unintentional poisonings (which includes cocaine deaths), see Moyer *et al.* (1989). In addition, the DAWN reporters identify drug deaths using the death certificate, toxicological information, autopsy report, and other sources. Thus, the information in DAWN-ME differs from the information in NCHS which includes only the information in the death certificate. Finally, DAWN-ME deaths should be higher because they include drug related deaths (for instance, an individual dying in a car accident caused by drug use). However, there is evidence that DAWN-ME undercounts these cases (Brookoff *et al*., 1993).

Nevertheless, the DAWN-ME is not necessarily superior to the NCHS vital statistics for tracking cocaine-related deaths across cities. Because participation in DAWN is voluntary, the surveillance system does not collect information from all eligible medical examiners and/or coroners in a metropolitan area in a given year (Drug Abuse Warning Network, 2003b). Therefore, the DAWN-ME figures are not representative of all cocaine-related deaths in any one area. We cannot rule out the possibility that even the DAWN-ME provides a lower estimate of the true number of cocaine deaths per capita in the metro areas it surveys. In addition, the DAWN system is restricted to select metropolitan areas. In contrast, vital statistics are available for the entire country, for a larger number of cities, and for cities with smaller populations.

The results in this study suggest that although vital statistics may under-report the number of cocaine-related deaths, it can be used to track changes in cocaine use over time for more areas in the country. The vital statistics may prove particularly important for drug surveillance in smaller cities or areas with historically low rates of drug abuse. Garfield and Drucker (2001) have shown that these cities have experienced the greatest increase in drug related deaths during the 1990s. Although statistics in any one small city are vulnerable to measurement error, the results in this study suggest that aggregated data from just three small or low-use cities provides an accurate picture of variations in drug deaths. Moreover, the ICD-9 coding system is used to report vital statistics throughout the world. Therefore, NCHS vital statistics can be used to compare trends in cocaine deaths in the U.S. to those in other countries.

This study shows that there are substantial differences in cocaine use over time in different cities. Some cities displayed little growth in cocaine use per capita over the past two decades. In contrast, other cities experienced either steady growth, or a rapid increase in growth at some point in time. These regional differences can be used to identify sociodemographic factors, policies, and public health interventions, which are associated with cocaine use. More generally, future studies of local variations in cocaine use can be conducted using data from the many cities with high agreement on annual changes in drug deaths in these two datasets.

Our analysis focused on cocaine use because of the large literature examining the negative consequences of this drug. However, during the last decade, there has been increased concern on the negative consequences of heroin and drug clubs. We used methods similar to those described in this article to calculate the number of heroin deaths and total drug deaths per capita in the NCHS vital statistics and DAWN-ME databases. Unfortunately, data on drug use seems less accurate for other drugs. The overall correlation for the annual number of heroin deaths per capita between NCHS and DAWN-ME was 0.53 (*versus* 0.78 for cocaine deaths). The correlation for the annual number of drug deaths was 0.61.

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